Procedure for Including IGRT in RTOG Protocols

DRAFT

Definition of IGRT

- Process extending from CT-simulation imaging through the step of imaging the patient on the treatment unit
  - Process includes the following steps:
    - manual or automatic registration of the two datasets
    - Determination of a series of mechanical movements of the patient support system to correct for detected positioning errors

Many Different Approaches to IGRT

- There are many different ways of imaging the patient in the treatment room

- There are many different ways for registering the CT-sim and IGRT datasets

- There are many different ways for adjusting the patient's position based on registration information

Procedure for including IGRT in RTOG Protocols

- Protocol must include IGRT specifications
- IGRT questionnaire
- Phantom Irradiation
  - Treatment units that do not include a robotic couch
  - Test to evaluate the performance of robotic couches with pitch and roll capabilities
- Image Registration Software Tests
  - Tests that use patient datasets

What is not Included

- **The guidelines presented here do not include IGRT techniques that use ultrasound or infrared systems that place fiducial markers on the patient's skin**

- **Deformable fusion methodologies are not included at this time**

Phantom Requirements

- Phantom must work for IGRT technologies that use either dual radiographic imaging or volume imaging
  - Both kV and MV imaging must be accommodated
  - All images must be artifact-free
- Using the treatment beam, markers can be visualize with either EPID, radiographic film, or radiochromic film

Phantom Requirements

- Phantom must check both linear and rotational couch adjustments.
- Phantom must work for collimators like BrainLAB that have a restricted field size
- Phantom must work for robotic systems like the CyberKnife unit

Solutions (Features)

- Simple cubic phantom made of acrylic
- Precision slide that holds three stainless steel balls (approx. 4 mm dia.)
  - Holes where ball markers are placed are used for artifact-free kV CT imaging
  - One ball is placed at the phantom center and the other two balls are shifted 4 cm from the center
- Phantom has extra base so that so that rotational errors of 3 degrees along a diagonal can be introduced between CT Simulation and IG at the treatment unit

Phantom Irradiation

- The steps in the process of Phantom Irradiation:
    1. Image the phantom using a diagnostic quality CT scanner
    2. Generate different treatment plans for each marker. Each of the three plans should have two orthogonal beams hitting a particular marker. The field sizes should be on the order of a 2.0 cm square or circle. The plans should be generated with the assumption that the phantom will NOT be moved to target each marker. Instead, for the CyberKnife unit, the accelerator must be moved to the next marker or, for isocentric units, the MLC must be adjusted for targeting each marker.

Phantom Irradiation

3. Move the phantom from the CT-Sim unit to the treatment unit and place it on special base that introduces small rotational errors

4. For treatment units that have a mechanical isocenter, set the central marker near this position.

5. For treatment units that do not have a physical isocenter, use the approximate isocenter of the imaging system to position the marker.

6. In both of the above situations, small linear errors should be introduced

Phantom Irradiation

7. Use the in treatment room image-guided capability to re-image the phantom.

8. Register the simulation and IG datasets to determine magnitude of setup errors.

9. Use these setup errors to correct positioning of phantom.

Phantom Irradiation

10. For one of the orthogonal beam directions, irradiate the three markers with three separate MLC settings.

11. Rotate gantry to second beam direction and repeat step 10.

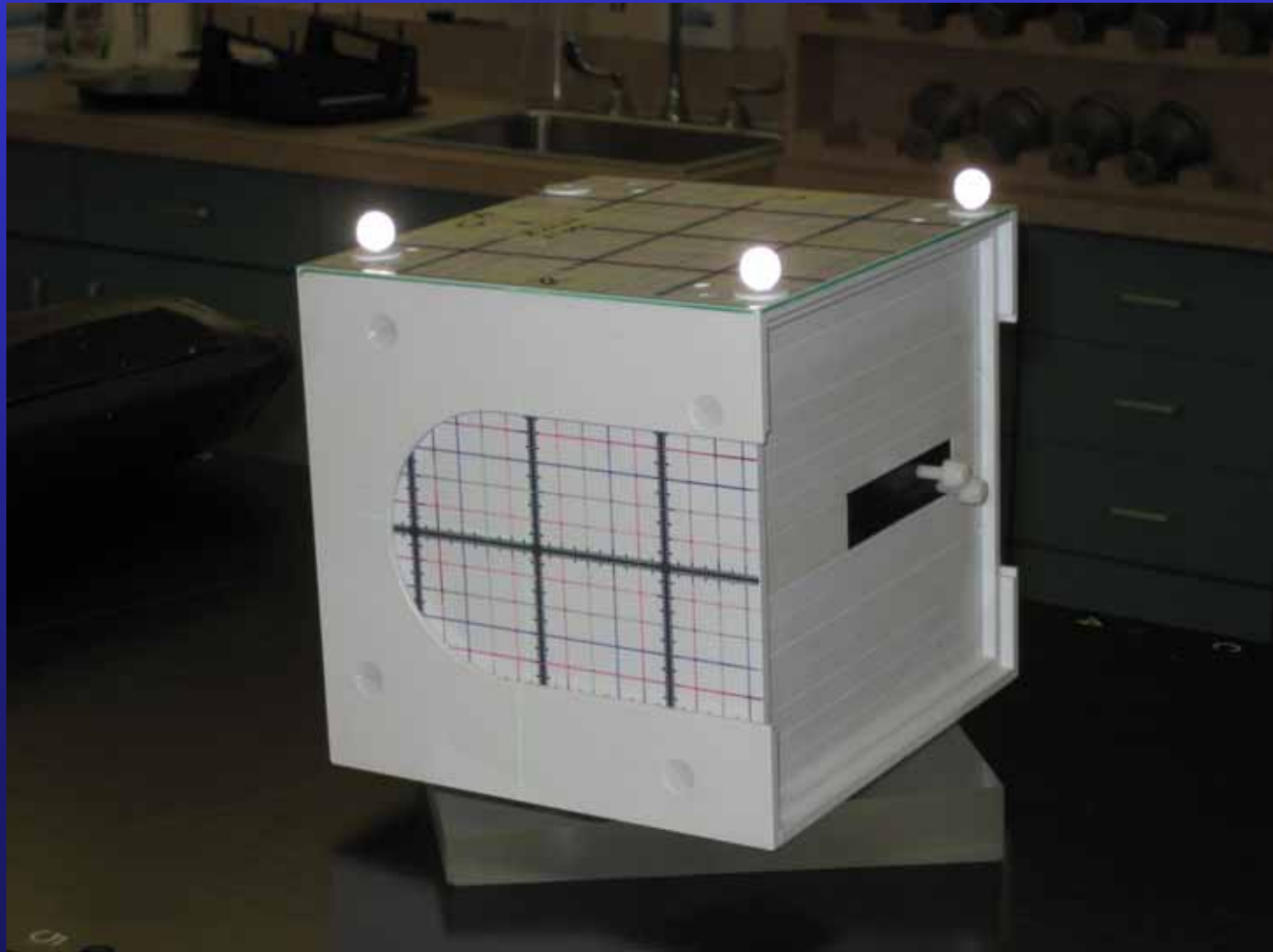12. Compare marker position for each image to the position shown in the DRR.

Using Phantom to Check Performance of Robotic Couches
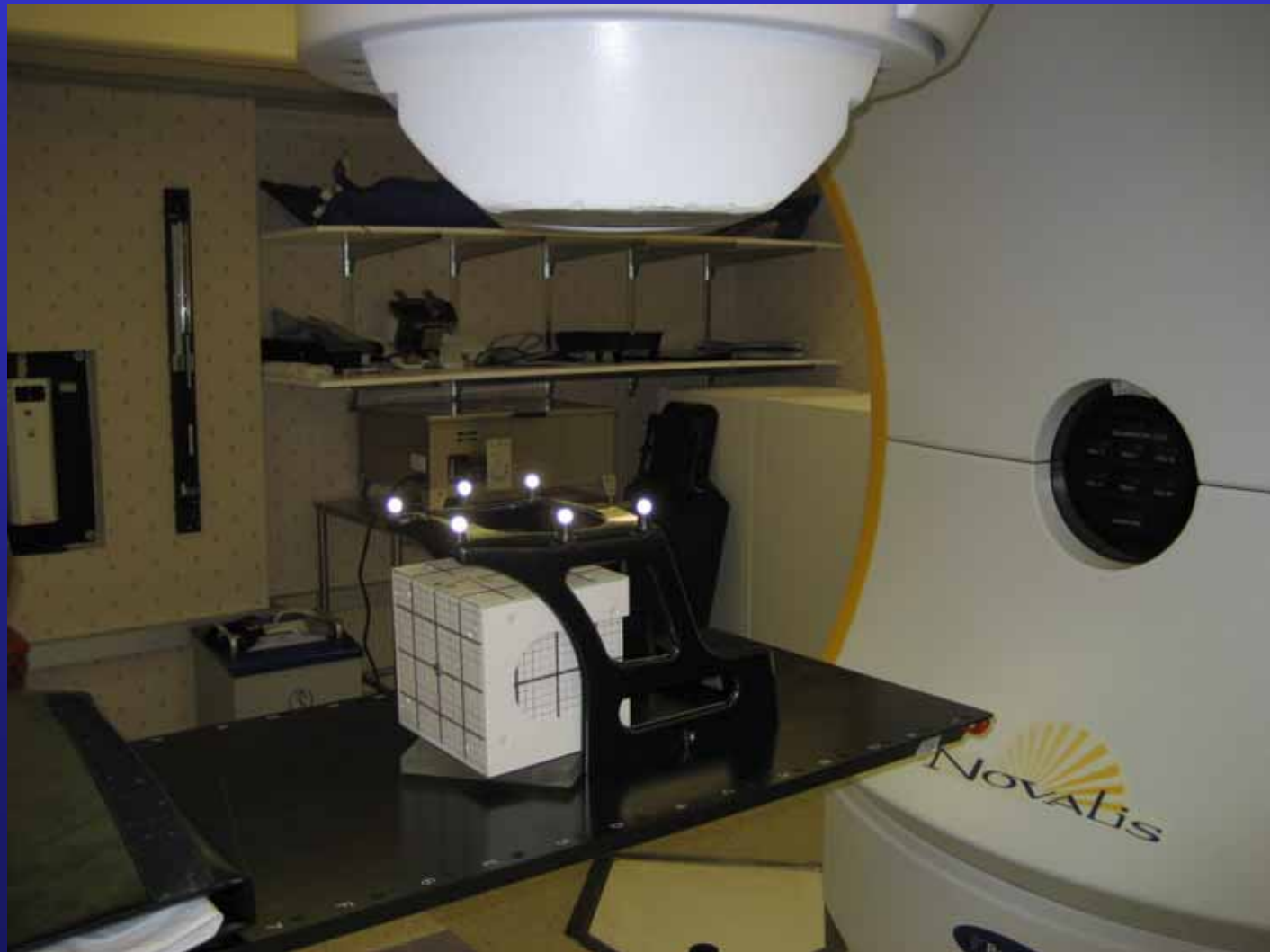
Using Phantom to Check Performance of Robotic Couches

Phantom Design

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Orthogonal Pair Shows Deviation Compared to DRR